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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/761,256	01/22/2004	Takashi Tonegawa	Q79466	2575

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EXAMINER

NGUYEN, THANH T

ART UNIT	PAPER NUMBER
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2813

SHORTENED STATUTORY PERIOD OF RESPONSE	MAIL DATE	DELIVERY MODE
3 MONTHS	12/27/2006	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

Office Action Summary	Application No. 10/761,256	Applicant(s) TONEGAWA, TAKASHI	
	Examiner Thanh T. Nguyen	Art Unit 2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 12 October 2006.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-13 is/are pending in the application.
- 4a) Of the above claim(s) 7-11 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-6 and 12-16 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Response to Arguments

Applicant's arguments with respect to claims 1-6, 12-16 have been considered but are moot in view of the new ground(s) of rejection.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claim 1-6, 12-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chamber et al. (U.S. Patent No. 2003/0137050) in view of an ordinary skill in the requisite art.

Referring to figures 1-8, Chambers et al. teaches a semiconductor device comprising:
a first Cu interconnection (see figure 1) including additive metal atoms (see paragraphs# 26, 32) and additive silicon atoms (see paragraphs# 35, 47, 58),
wherein a density of said additive metal atoms is higher in vicinities of bottom and side surfaces of said first Cu interconnection than in a vicinity of a top surface (see paragraphs# 26, 32) thereof,

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wherein a density of said additive silicon atoms is higher in said vicinity of said top surface than in said vicinities of said bottom and side surfaces (see paragraphs# 35, 47, 58),

Wherein the density of the additive silicon atoms ranges between 0.01 atomic % and 8 atomic % of total atoms in the first Cu interconnection (see paragraph# 35, 200-900ppm of silicon = 0.03-0.09 atomic percent silicon), and

Wherein the additive silicon atoms are diffused by irradiating the first Cu interconnection with silane-containing gas, such that the silicide reaction does not occur (see paragraphs# 35, 42, 47, 58). With regarding to the term “irradiation of the first Cu interconnection with the silane-containing gas” in claim 1 is method recitations in a device claimed, and they are non-limiting, because only the final product is relevant, not the method of making. A product by process claim is directed to the product per se, no matter how actually made. See also MPEP 2113. Moreover, an old or obvious product produced by a new method is not a patentable product, whether claimed in “product by process” claims or not.

Noted that the same process would provide the same results such that seed layer is formed comprising copper and other alloy metals and anneal at the temperature of 200-450°C. and exposing the copper (conductive) layer with silane at a low concentration of silicon to prevent the formation of silicide to improve electromigration reliability (see paragraphs# 26/32, 35/42/47/58).

Regarding to claim 2, additive metal atoms include atoms of one or more of metals selected from the group consisting of Al, Sn, Ti, Si, In, Ag, Zr, Ni, Mg, Be, Pd, Co, B, Zn, Ca, Au and Ga (see paragraph# 26).

Regarding to claim 3, a second Cu interconnection (see figure 1, metallization layer 1) overlying said first Cu interconnection (metallization layer 2) and including additive metal atoms and additive silicon atoms, wherein a density of said additive metal atoms in said second Cu interconnection is higher in vicinities of bottom and side surfaces of said first Cu interconnection than in a vicinity of a top surface thereof, and a density of said additive silicon atoms in said second Cu interconnection is higher in said vicinity of said top surface than in said vicinities of said bottom and side surfaces (see figure 1-8, paragraphs# 26/32, 35/47/58).

Regarding to claim 4, additive metal atoms in said second Cu interconnection include atoms of one or more of metals selected from the group consisting of Al, Sn, Ti, Si, In, Ag, Zr, Ni, Mg, Be, Pd, Co, B, Zn, Ca, Au and Ga (see paragraph# 26).

Regarding to claim 5, second Cu interconnection includes a Cu interconnection line and a via plug extending from said Cu interconnection line and connected to said first Cu interconnection (see figure 1).

Regarding to claim 6, the first Cu interconnection and said second Cu interconnection are connected together via a Cu plug covered with a barrier metal film (110/300, see figure 1+).

Regarding to claim 14, wherein an oxide layer is removed from the surface of the first Cu interconnection before diffusing the additive silicon atoms (see figures 4-5, this is a device claim as long as there is no oxide layer formed on the surface of the copper interconnection it would meet the claim limitation)

With regard to claim 14, 15, 16, the term “irradiation of the first Cu interconnection with the silane-containing gas is performed without exposing the first Cu interconnection to atmospheric air” in claim 14, “the silane-containing gas includes silane and nitrogen” in claim

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15, “the irradiation of the first Cu interconnection with the silane-containing gas is performed while heating a wafer of the semiconductor device” in claim 16 are method recitations in a device claimed, and they are non-limiting, because only the final product is relevant, not the method of making. A product by process claim is directed to the product per se, no matter how actually made. See also MPEP 2113. Moreover, an old or obvious product produced by a new method is not a patentable product, whether claimed in “product by process” claims or not.

However, the reference does not teach the specific density of the additive silicon atoms at the range of 0.01-8 atomic percent of total atoms such that density of the additive silicon atoms at the bottom surface is 0.01 atomic % and top surface of the copper is 8 atomic % of total atoms.

It would have been obvious to a person of ordinary skill in the requisite art at the time of the invention was made to optimize the additive silicon atom in the copper layer, since it has been held that where the general conditions of a claim are disclosed in the prior art (i.e.- density of the additive silicon atoms at the bottom surface is 0.01 atomic % and top surface of the copper is 8 atomic % of total atoms), discovering the optimum or workable ranges involves only routine skill in the art. In re Aller, 105 USPQ 233 (CCPA 1955).

The specification contains no disclosure of either the critical nature of the claimed arrangement (i.e.- wherein the density of the additive silicon atoms at the bottom surface is 0.01 atomic % and top surface of the copper is 8 atomic % of total atoms) or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen limitations or upon another variable recited in a claim, the applicant must show that the chosen limitations are critical. In re Woodruff, 919 F.2d 1575, 1578 (FED. Cir. 1990). In re Rose, 220 F.2d 459, 105 USPQ 237 (CCPA 1955), In re Rinehart, 531 F.2d 1048, 189 USPQ 143 (CCPA 1976)(“mere

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scaling up of a prior art process capable of being scaled up, if such were the case, would not establish patentability in a claim to an old process so scaled.” 531 F.2d at 1053, 189 USPQ at 148.). In *Gardner v. TEC Systems, Inc.*, 725 F.2d 1338, 220 USPQ 777 (Fed. Cir. 1984), cert. denied, 469 U.S. 830, 225 USPQ 232 (1984), the Federal Circuit held that, where the only difference between the prior art and the claims was a recitation of relative dimensions of the claimed device and a device having the claimed relative dimensions would not perform differently than the prior art device, the claimed device was not patentably distinct from the prior art device.

Therefore, it would have been obvious to a person of ordinary skill in the requisite art at the time of the invention was made would form the copper layer having the bottom surface of 0.01 atomic % of silicon and the top surface of 8 atomic % of silicon in process of Chambers et al. because the process would improve electromigration reliability.

Response to Arguments

Applicant's arguments with respect to claims 1-6, 12-16 have been considered but are moot in view of the new ground(s) of rejection

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

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A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thanh Nguyen whose telephone number is (571) 272-1695, or by Email via address Thanh.Nguyen@uspto.gov. The examiner can normally be reached on Monday-Thursday from 6:00AM to 3:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, can be reached on (571) 272-1702. The fax phone number for this Group is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956 (See **MPEP 203.08**).



Thanh Nguyen
Patent Examiner
Patent Examining Group 2800

TTN